National Aeronautics and Space Administration

EXPLORE EARTH

Space-Based Precipitation Activities Enabled by NASA Headquarters

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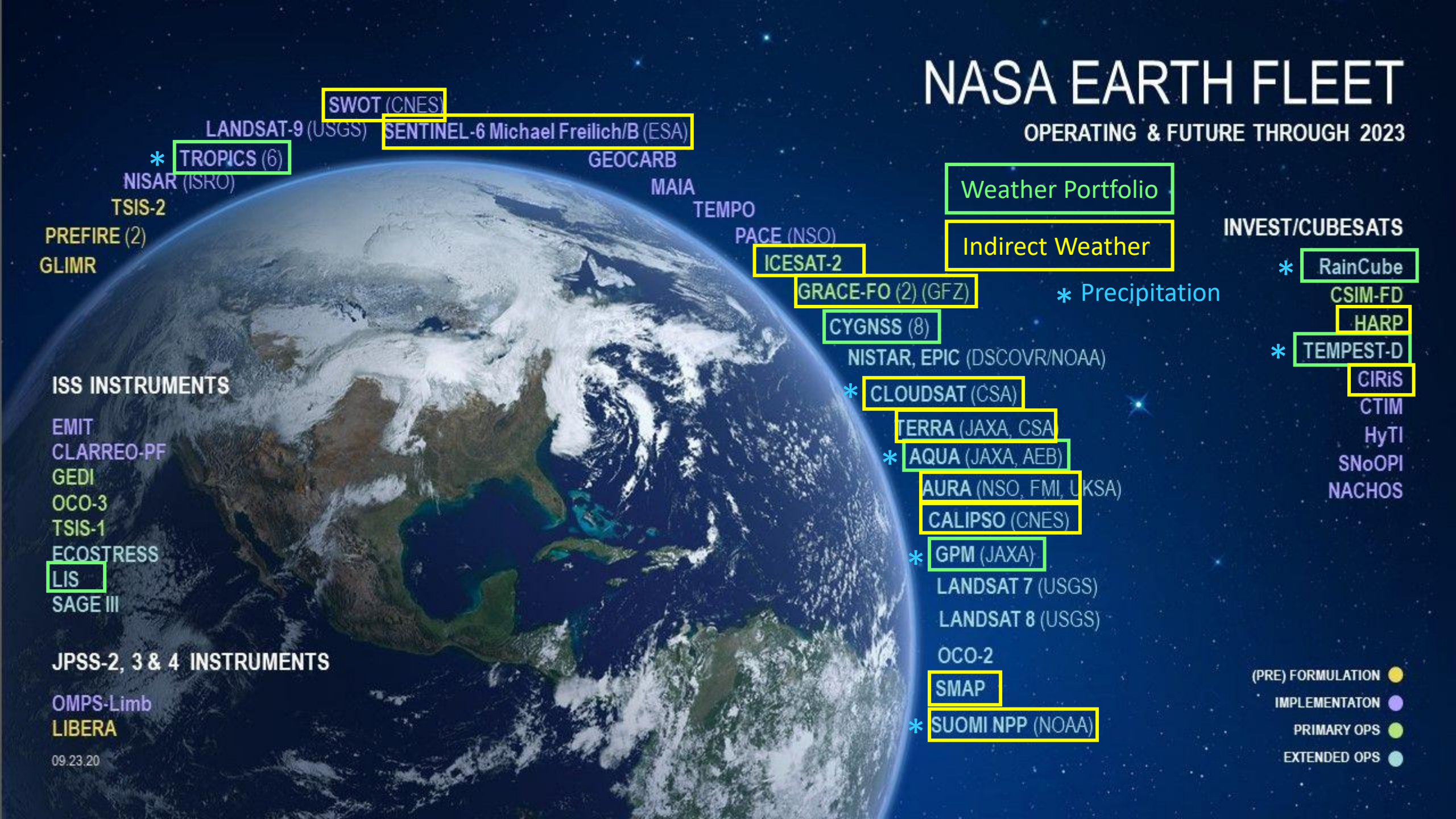
Earth Science Division, NASA Headquarters, Washington, DC

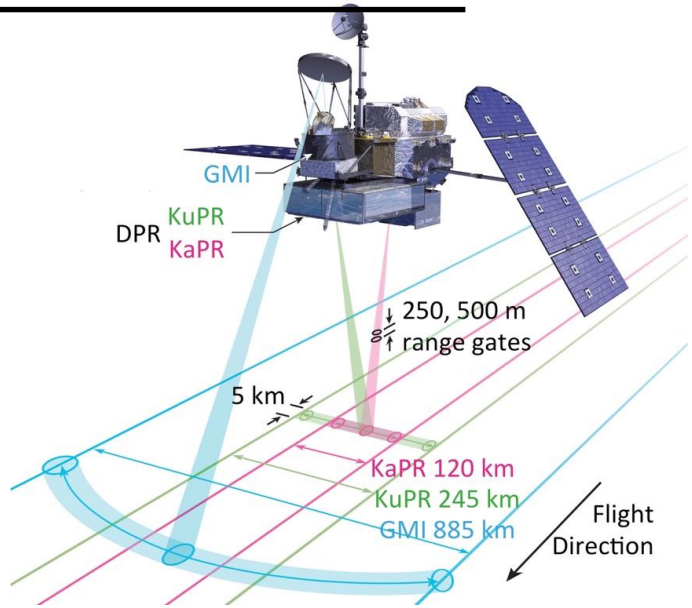
NOAA-DOE Precipitation Processes and Predictability Workshop

Wednesday, 2 December 2020

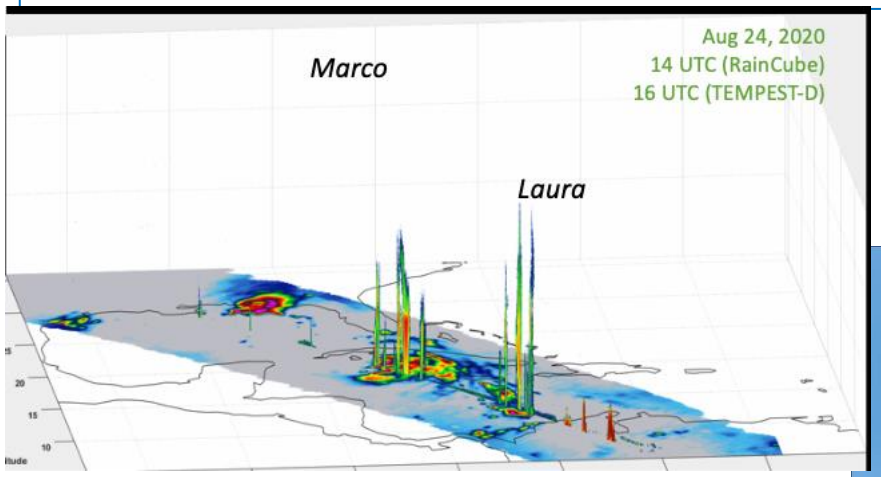

NASA EARTH FLEET
OPERATING & FUTURE THROUGH 2023
SWOT (CNES)
LANDSAT-9 (USGS)
SENTINEL-6 Michael Freilich/B (ESA)
* TROPICS (6)
GEOCARB
NISAR (ISRO)
MAIA
TSIS-2
TEMPO
PREFIRE (2)
PACE (NSO)
GLIMR
ICESAT-2
GRACE-FO (2) (GFZ)
CYGNSS (8)
NISTAR, EPIC (DSCOVR/NOAA)
* CLOUDSAT (CSA)
TERRA (JAXA, CSA)
* AQUA (JAXA, AEB)
AURA (NSO, FMI, UKSA)
CALIPSO (CNES)
* GPM (JAXA)
LANDSAT 7 (USGS)
LANDSAT 8 (USGS)
OCO-2
SMAP
* SUOMI NPP (NOAA)
Weather Portfolio
Indirect Weather
* Precipitation
INVEST/CUBESATS
* RainCube
CSIM-FD
HARP
* TEMPEST-D
CIRiS
CTIM
HyTI
SNoOPI
NACHOS
ISS INSTRUMENTS
EMIT
CLARREO-PF
GEDI
OCO-3
TSIS-1
ECOSTRESS
LIS
SAGE III
JPSS-2, 3 & 4 INSTRUMENTS
OMPS-Limb
LIBERA
09.23.20
(PRE) FORMULATION
IMPLEMENTATON
PRIMARY OPS
EXTENDED OPS

NASA Precipitation Satellites

Global Precipitation Measurement (PS: Braun, gpm.nasa.gov)

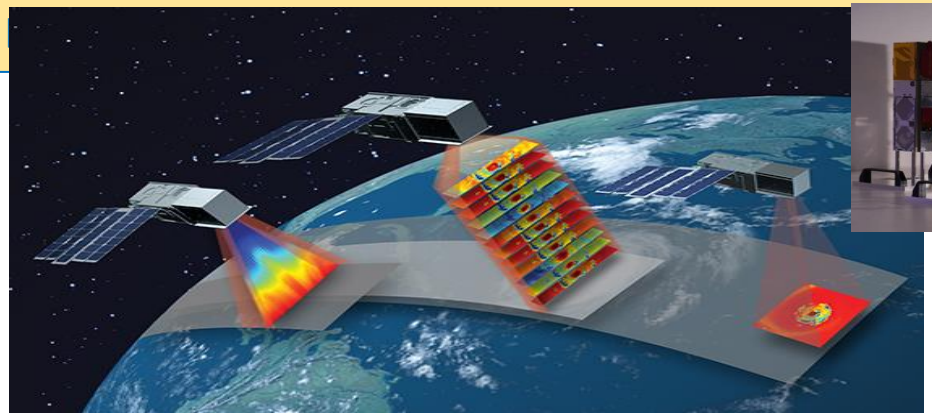


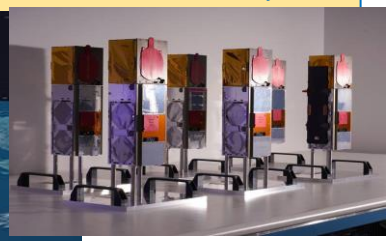
TEMPEST-D (PI: Reising, https://www.jpl.nasa.gov/cubesat/missions/tempest-d.php)



6 Unit CubeSat

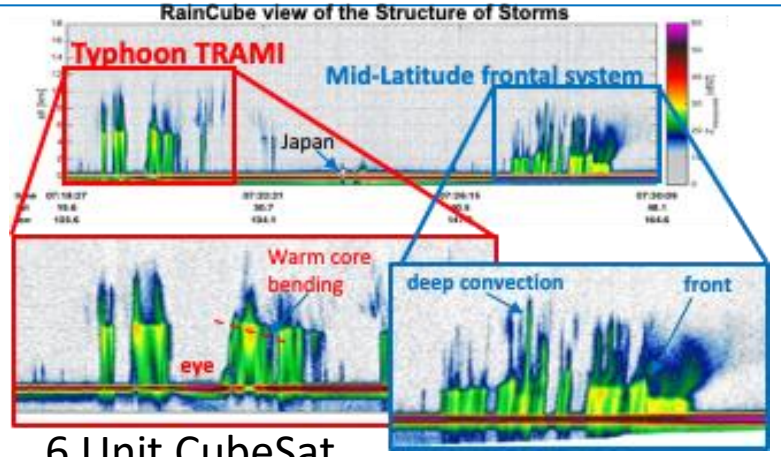
TROPICS (PI: Blackwell https://tropics.ll.mit.edu/CMS/tropics/Mission-Overview,



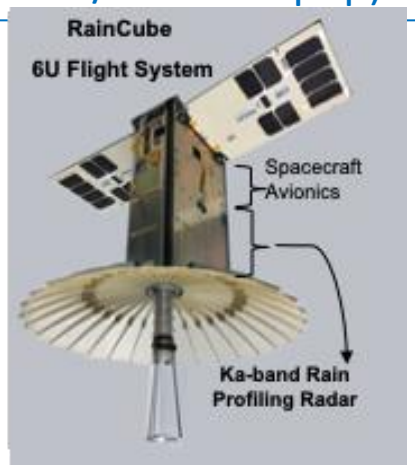


Six separate 3 Unit CubeSats

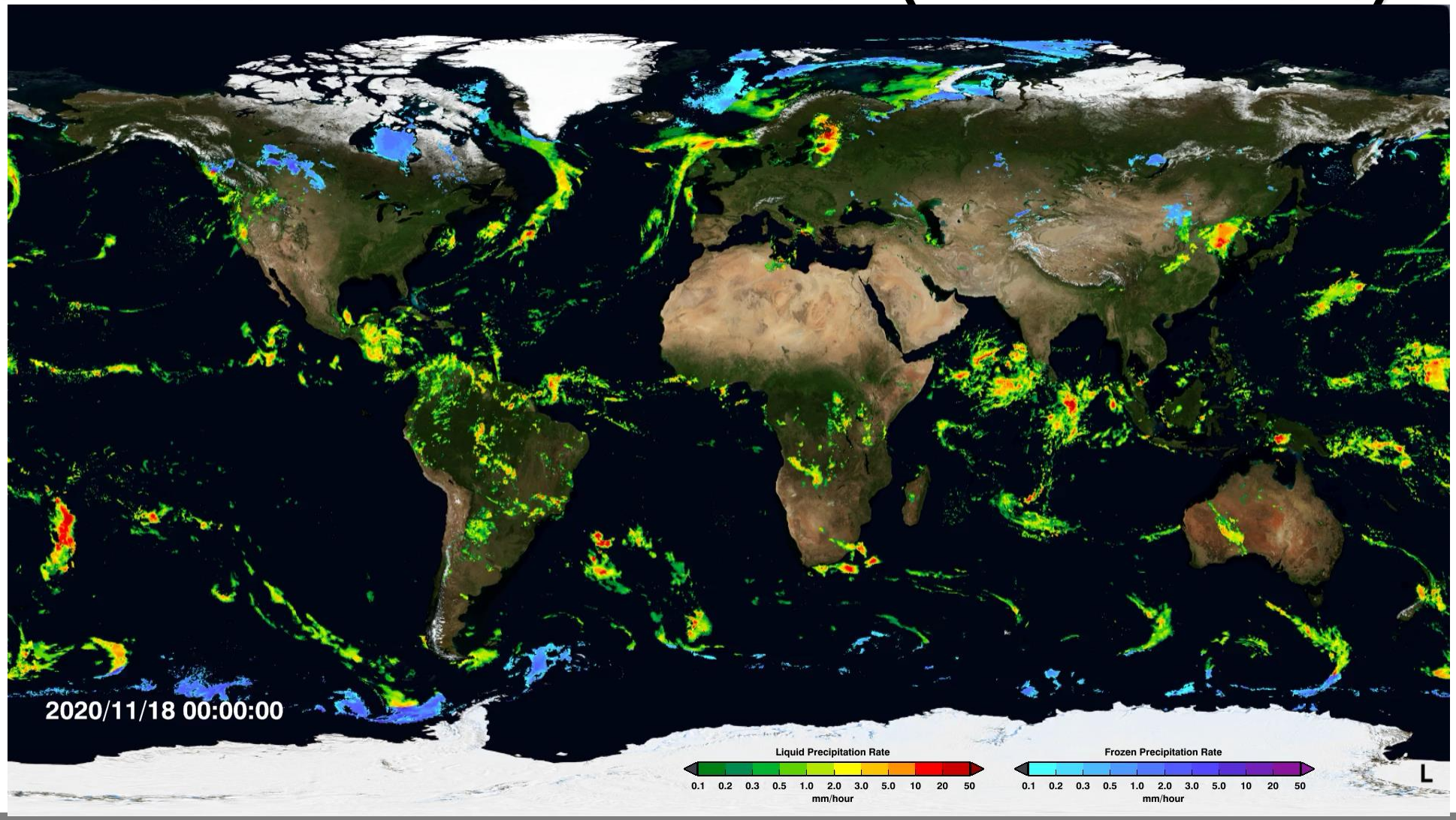
RainCube(PI: Peral, https://www.jpl.nasa.gov/cubesat/missions/raincube.php)



6 Unit CubeSat



GPM-CO and GPM-Constellation (11/18-11/25/2020)



Integrated Multi-satellitE Retrievals for GPM (IMERG)* provides precipitation estimates every 30 min at a 0.1° x 0.1° grid box and with a 4 hour latency (for applications) and ~3 month latency (for science users)

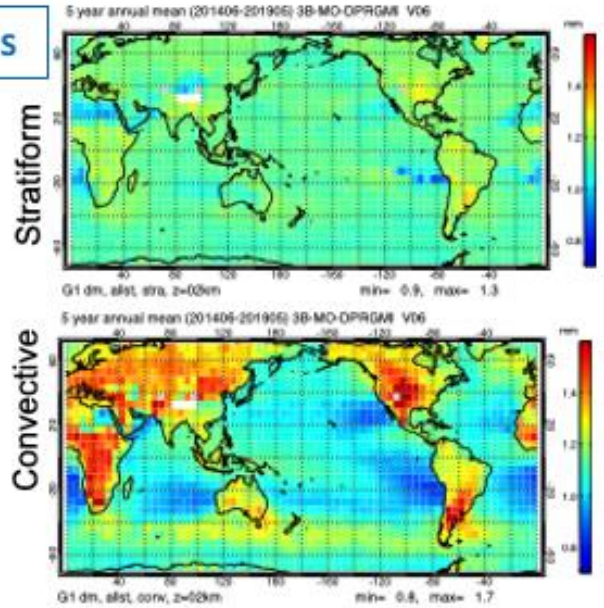
Liquid Precipitation Rate
0.1 0.2 0.3 0.5 1.0 2.0 3.0 5.0 10 20 50
mm/hour
Frozen Precipitation Rate
0.1 0.2 0.3 0.5 1.0 2.0 3.0 5.0 10 20 50
mm/hour

Some GPM Science Results

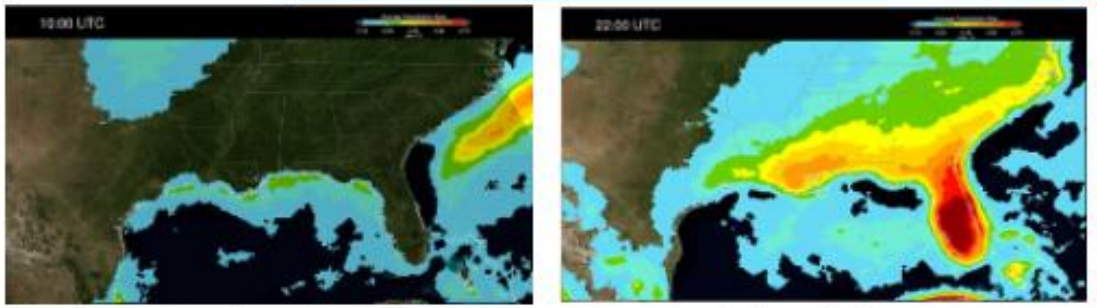
GPM Particle Size Distributions

As an advancement over TRMM, the GPM Combined Radar-Radiometer Algorithm retrieves the mass-weighted mean diameter, Dm (mm), globally at different altitudes.
Dm is larger over land than over ocean for both convective and stratiform precipitation types.

Courtesy of Mei Han (NASA/GSFC)



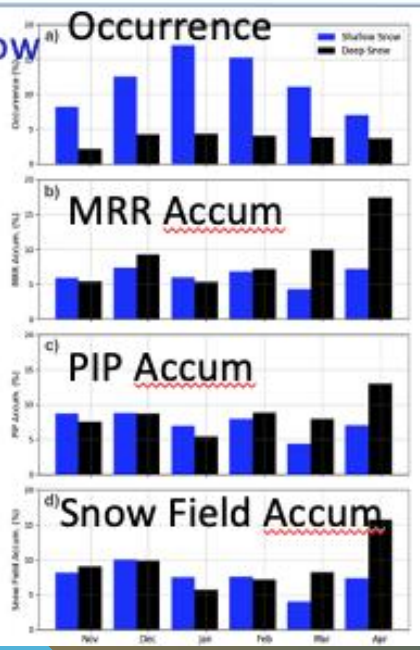
GPM Diurnal Precipitation (Tan et al, 2019)



The diurnal cycle over different regions around the globe was extracted from GPM's IMERG. This data reveals the intricate interplay between diurnal and seasonal variability. Accurate representation of precipitation variability in global models remains a challenge and this new insight can constrain the models.

Deep and Shallow Falling Snow Events (Pettersen et al, 2020)

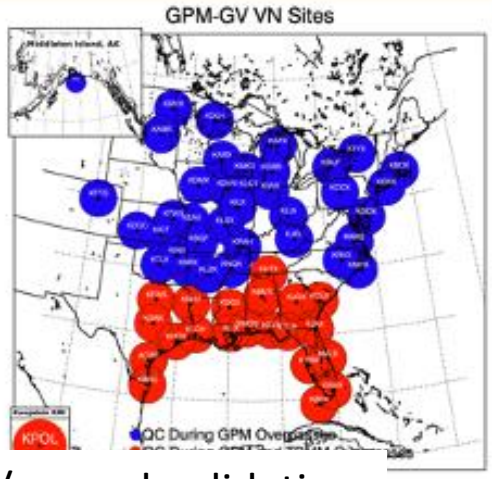
Four winter seasons of data from a precipitation instrument suite (augmented .....GPM instruments) based at National Weather Service Office Marquette, Michigan (250–500 cm of annual snow accumulation). Shallow snow events occur 2 times as often as deep events; however, both categories contribute approximately equally to estimated annual accumulation



GPM Ground Validation Multi-Radar/Multi-Sensor (MRMS) Precipitation Reanalysis and (separate) Validation Network

The MRMS data products were created using the NOAA MRMS System which ingests Weather Surveillance Radar 88 Doppler (WSR-88D) radar data, Rapid Update Cycle (RAP) model analysis fields, and gauge data.

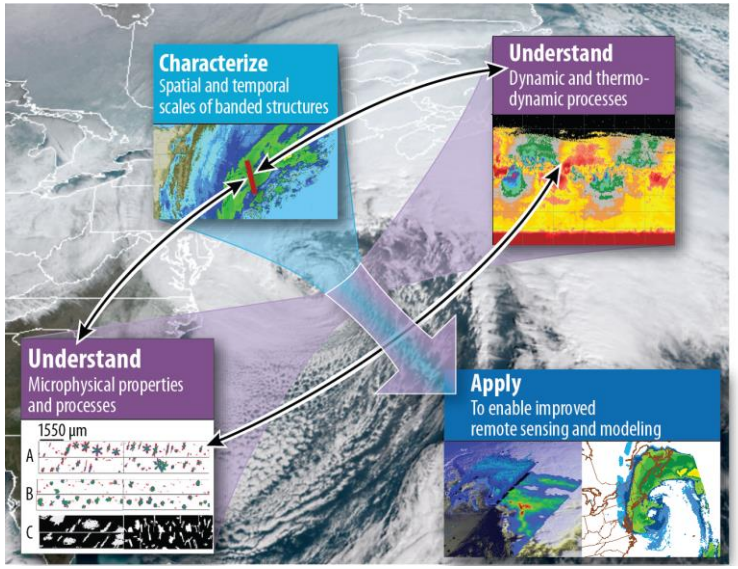
Validation Network---------->



https://gpm.nasa.gov/science/ground-validation

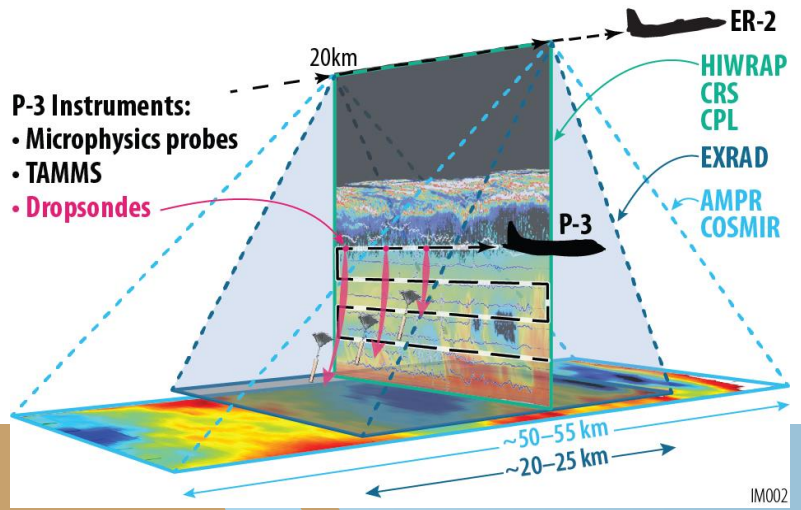
Precipitation Suborbital Flights

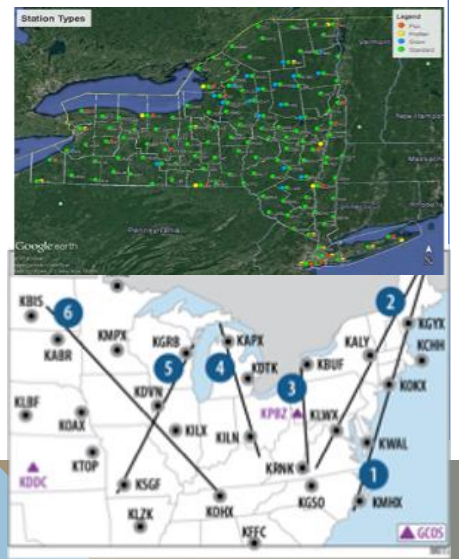
IMPACTS (PI: McMurdie https://espo.nasa.gov/impacts/)



First comprehensive field campaign to measure falling snow structures and properties in 30 years; Operations: Jan-Feb 2020 ☑; Jan-Feb 2021; Jan-Feb 2022

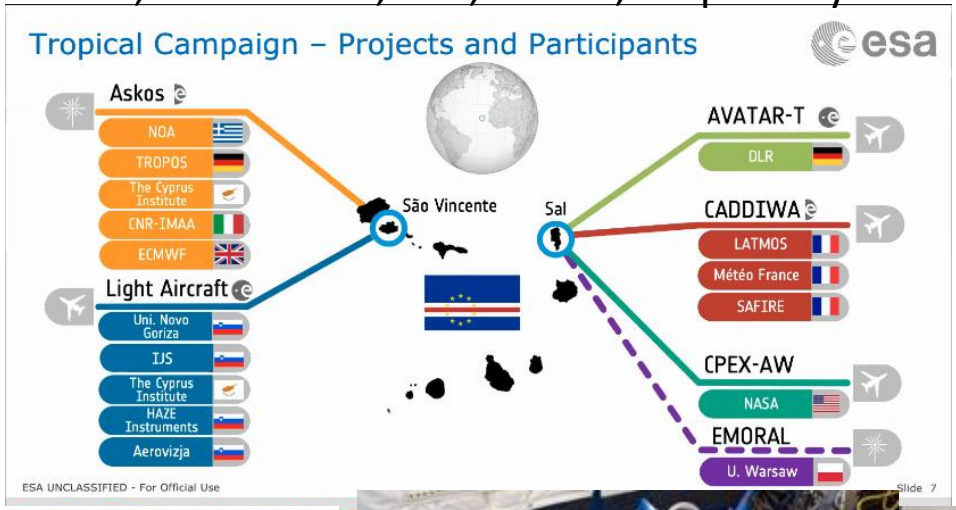
Aircraft and Ground Operations





CPEX-AW (https://espo.nasa.gov/cpex-aw/)

Cal/Val for ESA's Aeolus & joint with 5 other international teams; Convection, SAL, Winds, Tropical Cyclones, +;



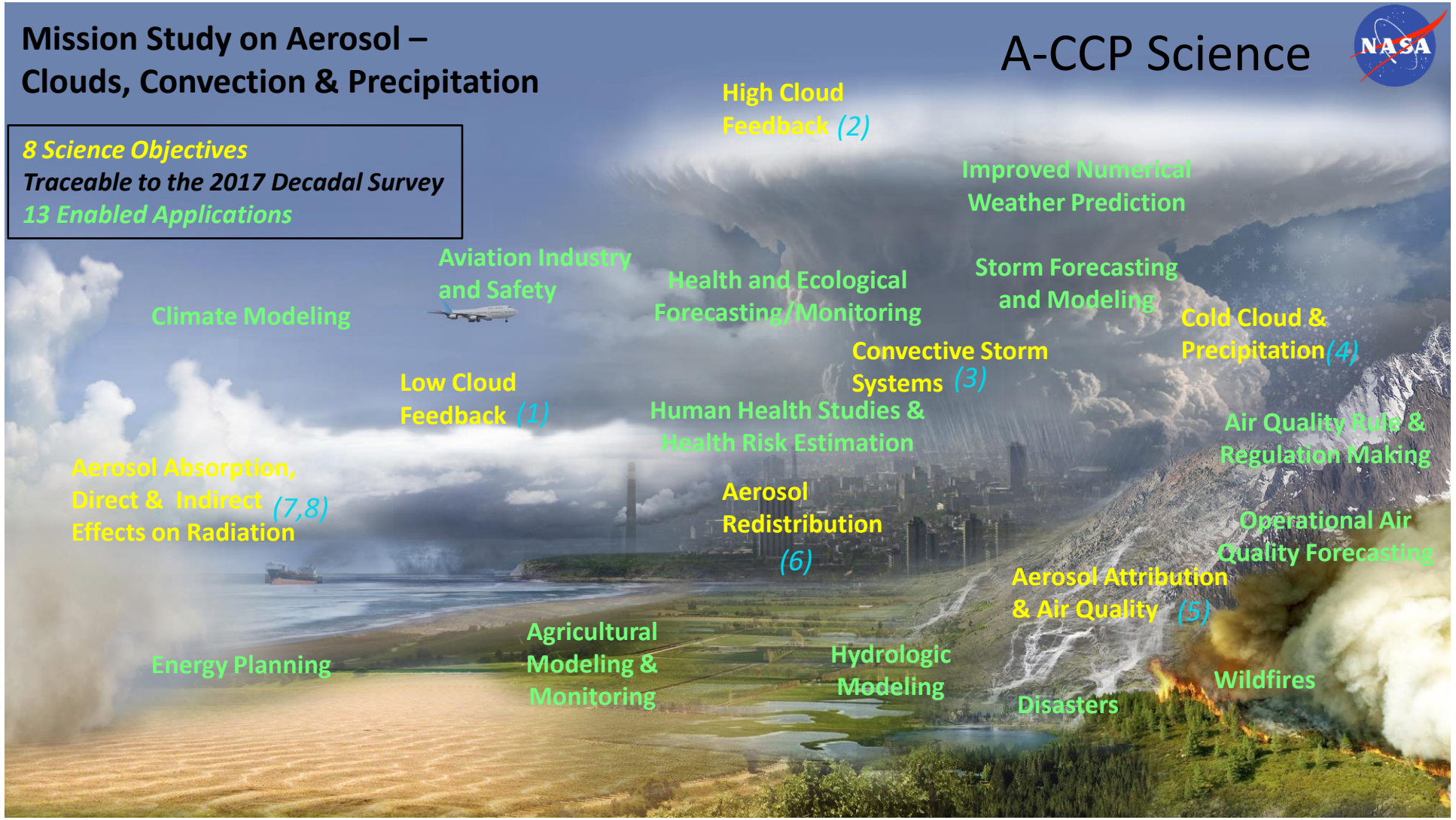
Likely NOAA G-IV to join; Summer 2021 (Covid postponed)

+HAMSR
+APR-3

NASA Research ROSES Solicitations with funding for Precipitation

ROSES Year	Solicitation Short Title	# Yrs of $
2017	Making Earth System Data Records for Use in Research Environments (MEaSURES)	5
2019	Interdisciplinary Science Urban Hydrometeorology Life Cycle of Snow	3
2019	Weather and Atmospheric Dynamics	3
2019	PBL Incubation Study Team	1
2019	Earth Science Research from Operational Geostationary Satellite Systems (Joint w/ NOAA NESDIS)	3
2019	Global Navigation Satellite System Research	3
2019	Remote Sensing Theory	4
2020	FINESST (Graduate Student funding)	3
2020	New Investigator Program (NIP)	3
2020	CYGNSS Science Team (proposals were due Nov 6, 2020)	3
2021	Precipitation Measurement Missions (expected to be due June 2021)	3
2021	TASNPP: Terra, Aqua, Suomi, NPP (due February and March 2021)	3
	And more	

2017 NASA Earth Science Decadal Survey: Aerosol & Clouds, Convection, Precipitation Designated Observable



Almost all of the Science Objectives and Enabled Applications are related to Weather, Precipitation and Atmospheric Dynamics